Technology Demonstration of Sensor Applications to Direct Push Platforms and Monitoring and Operations

Contract # F41624-00-C8045

Technical Report for Field Test 7
Period of Performance: March 2 – 7, 2004
Report Date: March 26, 2004

CDRL A001

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Report Documentation Page

Form Approved
OMB No. 0704-0188

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1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
26 MAR 2004	**N/A**	**2 Mar 2004 - 7 Mar 2004**

4. TITLE AND SUBTITLE
Technology Demonstration of Sensor Applications to Direct Push Platforms and Monitoring and Operations Technical Report for Field Test 7

5a. CONTRACT NUMBER
F41624-00-C8045

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Paul Jarski and Randy St. Germain

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
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8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Air Force Center for Environmental Excellence 3300 Sidney Brooks Road Brooks City-Base, Tx 78235 United States of America

10. SPONSOR/MONITOR'S ACRONYM(S)
AFCEE

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES
The original document contains color images.

14. ABSTRACT
Dakota Technologies, Inc. (DTI) demonstrated an uphole HaloProbe system for water sample analysis of halogenated compounds with the US Army Corps of Engineers (USACE) Kansas City District Site Characterization and Analyses Penetrometer System (SCAPS) crew. In February 2004, the Kansas City District (KCD) and Mr. Jerry Hansen of AFCEE coordinated the mobilization of equipment and personnel to Grissom Air Reserve Base (ARB) near Peru, IN and Rickenbacker International Airport (IAP), Columbus, OH. Both sites are former Air Force Bases. These sites provided excellent opportunities to test the uphole HaloProbe system and provide beneficial subsurface information to the Air Force Real Property Agency. The work occurred over 5 days. A total of 12 well points were installed at Grissom and 9 well points at Rickenbacker. Water level and HaloProbe measurements were recorded for each well.

15. SUBJECT TERMS
Halogen Specific Detector, Haloprobe, chorinated solvents, water samples, sensors, direct push, real-time, SCAPS, CPT

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**UU**	**21**	

Background

Dakota Technologies, Inc. (DTI) demonstrated an uphole HaloProbe system for water sample analysis of halogenated compounds with the US Army Corps of Engineers (USACE) Kansas City District Site Characterization and Analyses Penetrometer System (SCAPS) crew. In February 2004, the Kansas City District (KCD) and Mr. Jerry Hansen of AFCEE coordinated the mobilization of equipment and personnel to Grissom Air Reserve Base (ARB) near Peru, IN and Rickenbacker International Airport (IAP), Columbus, OH. Both sites are former Air Force Bases. These sites provided excellent opportunities to test the uphole HaloProbe system and provide beneficial subsurface information to the Air Force Real Property Agency. The work occurred over 5 days. A total of 12 well points were installed at Grissom and 9 well points at Rickenbacker. Water level and HaloProbe measurements were recorded for each well.

DTI personnel shipped the uphole HaloProbe system and support equipment to Indiana on 27 Feb 2004. The KCD SCAPS truck and support equipment left Kansas City on 1 Mar. All equipment and personnel were on site at Grissom ARB the afternoon of 2 March.

Objectives

1. To test the uphole HaloProbe instrument constructed for AFCEE under this Broad Agency Announcement (BAA) contract

2. To collect high quality and quantity data to characterize the extent of TCE contamination in the subsurface at Grissom ARB, Peru, Indiana and Rickenbacker IAP, Columbus, Ohio.

Sensors Tested

Uphole HaloProbe System

The uphole HaloProbe system consists of a halogen specific detector, an adsorbent trap, and a purge vessel for analysis of chlorinated VOCs at part per billion levels. The uphole HaloProbe system was designed to augment the downhole HaloProbe system. The downhole system is used to detect low dissolved phase (100 ppb-1 ppm) to free product halogenated compounds in situ. Together the two probes cover the entire concentration range from MCL levels to free phase product. The uphole system was constructed to work with the control and collection electronics previously integrated into the KCD SCAPS truck for the downhole system.

Site Activities

Grissom Air Reserve Base (ARB)

DTI personnel arrived in Kokomo, IN on Tuesday, March 2 at approximately 2:00 PM. DTI and KCD personnel met at building 190 on Grissom ARB. The crew located the area of investigation, marked the potential push locations and talked to the AFRPA (Air Force Real Property Agency) representative about the status of the utility clearance. At the same time, the uphole HaloProbe system was unpacked and installed into the SCAPS truck.

The general purpose of the field work is presented above under objectives. The specific purpose of the work at Grissom was to use the uphole halogen detector to delineate the extent of an apparently anomalous occurrence of TCE in ground water. Previous investigations had shown volatile contamination close to building 190 and apparently associated with a catch basin and

sewer pipe. This contamination dropped off away from the building. A series of borings which were nondetect lay in between the contaminated zone near the building and the anomalous occurrence of TCE in SB09.

On 3 March, a calibration of the system was performed to determine if the system was functioning properly. After a successful calibration, DTI personnel continued to experiment with the system while KCD waited for a final utility clearance and obtained a concrete core drill from a rental agency. The first four locations were predrilled through 2 inches of asphalt and 10 inches of concrete.

After the concrete was cored, a temporary well point was installed at the first location. This location was selected based on the concentration of TCE found in a grab sample of ground water obtained during a previous investigation. This first push was adjacent to previous boring SB09. The well point was sampled and analyzed by the uphole HaloProbe system. A total halogen concentration of 11 ppb TCE equivalent was identified. This concentration was similar to the 13 ppb identified at SB09 in the spring of 2003. To expedite in-situ sampling, a concrete coring business was contacted to drill the remainder of the hole locations and temporary well point installation and sampling was continued on the following day.

The SCAPS was used to push uninstrumented rods into the ground for the purpose of installing these temporary well points. The well points consisted of 3/4 inch inside diameter (ID) schedule 40 poly vinyl chloride (PVC) riser and screen. The installation method proceeded by first placing a sacrificial drive point and screen into the leading push rod. An annular seal consisting of a foam insert and a prepacked bentonite sleeve was placed above the screen. Push rods and PVC riser were added as the push was made to the selected depth. After reaching the desired depth, the push rods were retracted and the well point was sampled. Upon completion of the sampling, the PVC was cut off and capped close to the ground surface. A temporary well point consisting of ¾ inch ID screen and riser, a bentonite and foam seal, and an aluminum drive point was left in place. The depth of the well points was selected based on the available existing information. A review of the previous boring logs showed most of the water samples in the spring of 2003 had been obtained from temporary wells set between 13 and 15 feet. The actual open area of the well for those 2003 samples was unknown. All the well points installed during this March 2004 effort were installed to 14.5 feet and had a 5 foot long screen. The open interval was approximately 9.5 to 14.5 below ground surface. After all HaloProbe and water level measurements were obtained, seven of the well points were removed and the holes were grouted with cement/bentonite grout. Five of the well points were completed with flush 6 or 8 inch diameter flush mount covers.

The up whole HaloProbe was packed for travel to Rickenbacker IAP. On 5 March, the flush mounted well point covers were completed, coordinates were obtained with a Garmin GPS and the SCAPS truck was packed for travel to Rickenbacker.

Rickenbacker International Airport (IAP)

DTI personnel arrived in Columbus, OH on Friday, 5 March at approximately 1:00 PM. DTI and KCD personnel met representatives of the AFRPA to discuss sampling locations. The locations were based on results of the HaloProbe demonstration conducted at Rickenbacker 3

months previously. The uphole HaloProbe system was unpacked and re-integrated into the SCAPS truck and a single point calibration was performed.

On Saturday, 6 March, temporary well point installation and sampling began. As the water samples were removed from the subsurface the uphole HaloProbe system was used to analyze the samples. Well points were installed at seven locations selected by Shaw Environmental and Mr. Al Friedstrom. Two well points were installed at two of the locations. The first two well points were installed with 5 foot screens. After consultation with Shaw Environmental, ten foot long screens were installed in order to relate sample results to data from existing monitor wells. At the two locations where 5 foot screens had been installed, additional shallow 5 foot screens were installed so a ten foot section of aquifer could be sampled. Seven soil samples were collected from 4 locations. Soil sample holes were backfilled with granular bentonite. Well points were left in place so they could be resampled by Shaw Environmental at a later date Granular bentonite was placed around the top of each well point.

On the morning of 7 March, the uphole HaloProbe system was re-packaged for shipment back to the DTI facility. DTI and the SCAPS crew left Rickenbacker the afternoon of 7 March.

Data Collection

Initial startup of uphole HaloProbe system

The following startup procedure was used at the beginning of each day for the HaloProbe system:

The flow rate of air to the carrier gas delivery line was set to 40 mL/min with a backing pressure of 15 psig. The carrier gas return line was immersed in water to confirm that the carrier gas was flowing through the entire system. If adequate airflow was present, the data collection program was started. Next, the heater controllers for the detector were turned on; the detector was allowed to reach its operating temperature of 1080 ºC. Data collection continued until the baseline detector signal and detector temperature had been stable for five minutes. The run was ended, the data file name was recorded, and the data file was saved to the hard drive and a floppy disk.

Calibration and Analysis Procedure for uphole HaloProbe system

The following procedure was used to analyze water samples collected at both Grissom ARB and Rickenbacker IAP:

Calibration Procedure

1) Prepare five TCE solutions in concentrations of 500, 100, 50, 10, and 5 ppb using serial dilution method. The TCE solution concentrations used for calibrating the HaloProbe will depend on the concentrations expected at the site.

2) Ensure that the two valve arrows are pointing towards each other, parallel to the ground

3) Start collection software, collect baseline for one minute.

4) Starting with the lowest concentration solution, dispense a 5.0 mL aliquot of the sample into a clean test tube.

5) Attach test tube to purge and trap system; ensure that the test tube is seated at very top of fitting.

6) At one minute mark, flip both valves to the upright position to begin purging the sample with carrier gas. Immediately start timer, purging for the same length of time for each sample (nominally 1.5 minutes).

7) When the purge is complete, flip both valves back to the parallel position, pointing to each other.

8) Empty test tube into appropriate waste container and allow signal to return to baseline.

9) Repeat procedure for remaining five TCE calibration solutions.

10) End run, record data file name, and save data file to a floppy disk.

Sample Analysis Procedure

1) Ensure that the two valve arrows are pointing towards each other, parallel to the ground

2) Start collection software, collect baseline for one minute

3) Dispense a 5.0 mL aliquot of VOC free water into a clean test tube.

4) Attach test tube to purge and trap system; ensure that the test tube is seated at very top of fitting

5) At one minute mark, flip both valves to the upright position to begin purging the sample with carrier gas. Immediately start timer, purging for the same length of time for each sample (nominally 1.5 minutes)

6) When the purge is complete, flip both valves back to the parallel position, pointing to each other.

7) Empty test tube into appropriate waste container and allow signal to return to baseline.

8) Repeat steps 3-7 for groundwater sample.

9) Repeat steps 3-7 for another VOC free water blank.

10) End run, record data file name, and save data file to a floppy disk.

Field Modifications

During the first day of operation unexpected noise was encountered between the HaloProbe detector and the trap heating circuitry. This noise created enough ripple in the HaloProbe signal to make detection of low concentration signals very difficult. This problem had not been encountered at DTI's facilities, and it was unclear why it occurred. An attempt to correct the noise was unsuccessful. To alleviate the problem, the trap and heating circuitry were disconnected from the system and analysis was done by routing the VOC laden vapors directly from the purge vessel to the detector. This arrangement allowed for analysis of water samples to approximately 4 ppb which was below the MCL for TCE. However, the system will be modified after return to DTI's facilities to allow for use of the adsorbent trap.

During the second day of operation at Grissom ARB, two of the samples saturated the detector. Consequently, these two samples were diluted by a factor of ten and re-analyzed. This dilution factor was sufficient to bring the signal on scale.

Data Processing

Once DTI personnel were back in Fargo, the calibration logs were used to change the water sample results from voltages to concentrations. For those water samples which were diluted, the resultant concentration was multiplied by an appropriate dilution factor. The following sections discuss the results obtained at each site

Data Interpretation

Grissom ARB

Previous investigations had shown volatile contamination associated with a catch basin and sewer pipe close to building 190. As previously stated, the contamination concentration dropped to non-detect in the paved lot south of building 190. However, an anomalous occurrence of TCE in a grab ground water sample from soil boring SB09 was found outside of the nondetect area. The first temporary well point, SCAPS 01, was installed near this location. The total halogenated VOC concentration measured at this point was 11 ppb which was similar to the 13 ppb identified in SB09 in the spring of 2003. The total halogenated VOC concentration for each of the remaining well points is shown in Table 1.

Table 1. Depth to water and halogenated VOC concentrations at each monitoring point

Well Point ID	Depth to Water (ft) Below ground surface	Disposition	Concentration in ppb TCE equivalents
SCAPS 01	6.25	pulled and grouted	11 (within 2 ft of SB09)
SCAPS 02	6.2	pulled and grouted	14
SCAPS 03	6.22	flush mount cover; left in place due to field identified concentration	1536
SCAPS 04	6.45	pulled and grouted	<4
SCAPS 05	6.3	flush mount cover; left in place due to field identified concentration	27
SCAPS 06	6.25	pulled and grouted	1183
SCAPS 07	6.0	flush mount cover; left in place due to location at field identified	7

		edge of contamination	
SCAPS 08	6.85	pulled and grouted	<4 (near MW 4, building 106, and sewer line)
SCAPS 09	7.0	pulled and grouted	<4 (near MW 4, building 106, and sewer line)
SCAPS 10	6.45	flush mount cover; left in place due to location at field identified edge of contamination	<4
SCAPS 11	6.55	pulled and grouted	<4
SCAPS 12	6.48	flush mount cover; left in place due to field identified concentration	11

An attempt was made to define the extent of the contamination around SCAPS 01 and adjacent SB09 (Figure 1). This was relatively successful on three sides but on the fourth side towards the south east, two of the SCAPS well points had approximately 2 ppm. SCAPS 3 had 1.54 ppm TCE equivalents and SCAPS 6 had 1.18 ppm TCE equivalents. Unfortunately these well points were close to the boundary of the area which had been cleared for utilities so further investigation to the southeast was not possible. The contour plot (Figure 2) shows the identified extent of the anomalous region indicated by SB09. The contour plot (generated in Matlab) and groundwater flow patterns, at least seasonally, support a possible contaminant origin south to south east of the paved lot.

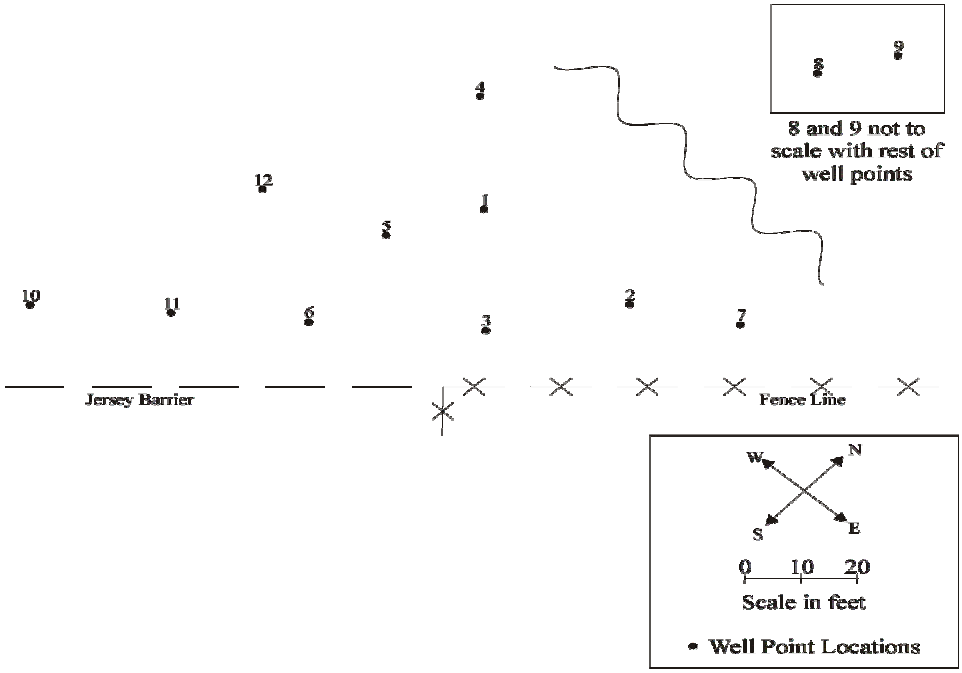


Figure 1. Well point locations near building 190

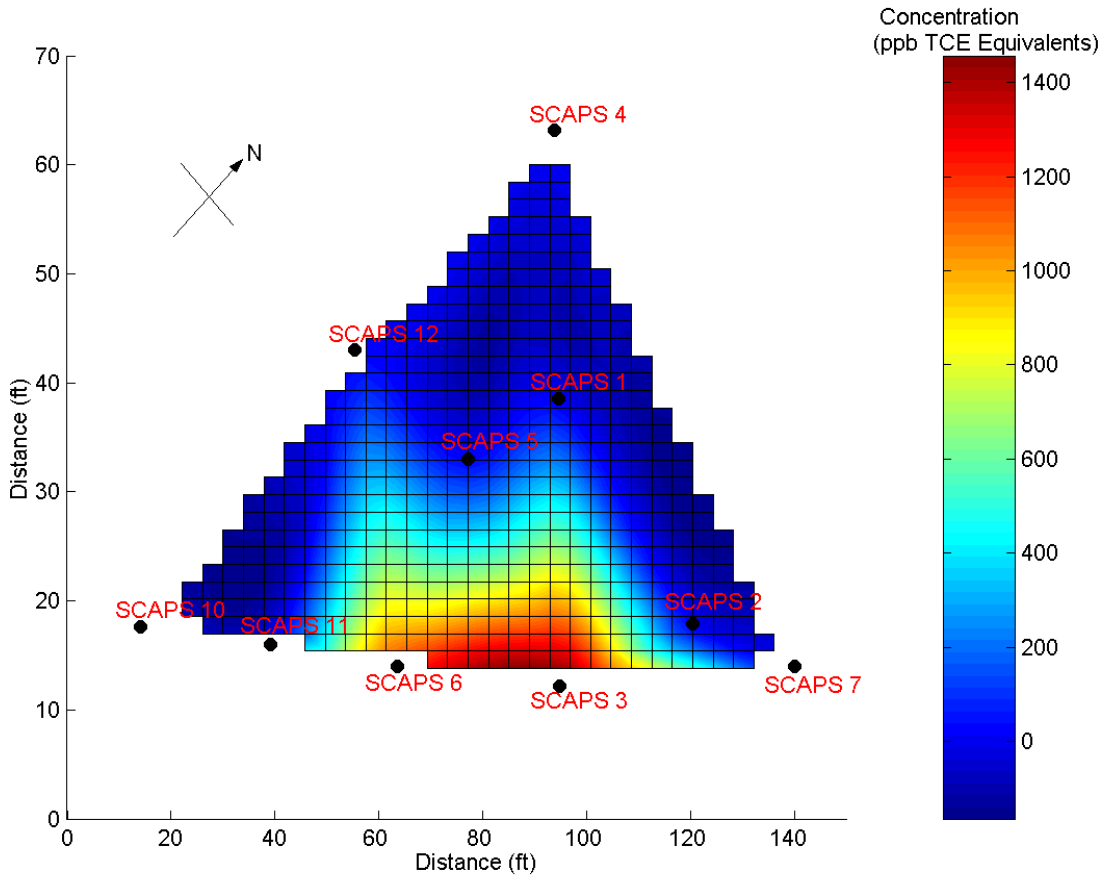


Figure 2. Contour plot of halogenated VOC concentrations at building 190

Rickenbacker IAP

The SCAPS crew and DTI personnel returned to Rickenbacker on March 5, 2004. Well points were installed at seven locations selected by Shaw Environmental and AFRPA. These points were placed near locations that had been previously investigated with the downhole HaloProbe system. The first two well points were installed with 5 foot screens but after consultation with Shaw Environmental ten foot long screens were installed in order to relate sample results to data from existing monitor wells. At the two locations where 5 foot screens had been installed (SCAPS wells 1 and 7), additional shallow 5 foot screens were installed so a ten foot section of aquifer could be sampled. Table 2 contains the well point information and uphole HaloProbe results from each sample point.

Table 2. Well point information gathered at Building 848 site Rickenbacker IAP

Well Point ID	Screen Interval (ft)	Refusal	Depth to water (ft)	uphole HaloProbe Results (non-detect <4 ppb TCE equivalents)
SCAPS well 1 d	17-22	no	4.76	Non detect

SCAPS well 1 s	12-17	no	4.5	Non detect
SCAPS well 7 d	15 – 20	no	4.34	Non detect
SCAPS well 7 s	10 -15	no	4.12	12 ppb TCE equivalents
SCAPS well 14	10 – 20	no	5.33	Non detect
SCAPS well 16	8.7 - 18.7	YES	6.0	Non detect
SCAPS well 18	10 -20	no	6.23	Non detect
SCAPS well 20	9.5 -19.5	YES	6.13	Non detect
SCAPS well 22	10-20	no	5.7	Non detect

Only one of the water samples contained detectable levels of halogenated VOCs. This was in good agreement with the results from the previous field effort as most of the VOCs present at this site were located in the top ten feet of the subsurface (refer to Contract # F41624-00-C8045 Technical Report for Field Test 6 for further information).

Equipment Performance

The performance of the uphole HaloProbe system was the primary focus of this work. In general the fieldwork was very successful, demonstrating that DTIs' uphole HaloProbe system can be used in conjunction with temporary small diameter well points to produce quality data at sites with concentrations near MCL levels.

During the uphole HaloProbe work, there were a few hardware problems, but none of the problems halted the work. The following is a list of problems encountered and their resolution.

Problem	Resolution
Noise pickup on detector from trap heating circuitry	Removed trap and routed sample vapor directly to detector
Sample saturated detector at two locations	Diluted sample and re-ran on system
Interfering species noted in distilled water purchased at site	Replaced distilled water with spring water for solvent in calibration solutions. This lessened but did not completely eliminate the problem

The uphole HaloProbe system generally performed well throughout the fieldwork. The main problem area was the noise pickup encountered during the first day of work. While the trap system was not ultimately needed, this problem needs to be fixed since, in some applications, the trap will be vital.

Recommendations
The detector's signal and bias lines should be better insulated to prevent noise pickup from the surroundings. This will allow use of the trapping system, which will be useful in applications where the uphole HaloProbe is used in conjunction with an MIP. In this case, there will not be nearly as much cVOCs crossing the membrane so a concentration step will be advantageous. Also, when the trap is used with water samples a "sharper" peak will be generated; that is the peak height of the desorbed analyte(s) will be higher but the peak area will stay the same. In this way a better LOD will be realized even with lower detector temperatures. These lower detector temperatures will allow for longer detector life.

A means of reproducibly getting VOC free water should be determined. This may involve re-filtering locally available distilled water, shipping ultrahigh purity water to each site, or using commercially available spring water.

Develop Excel spreadsheet templates that allow for quicker conversion of the data from raw voltages to concentrations.

Appendix

Appendix A is a compilation of data and maps for Grissom ARB, IN:

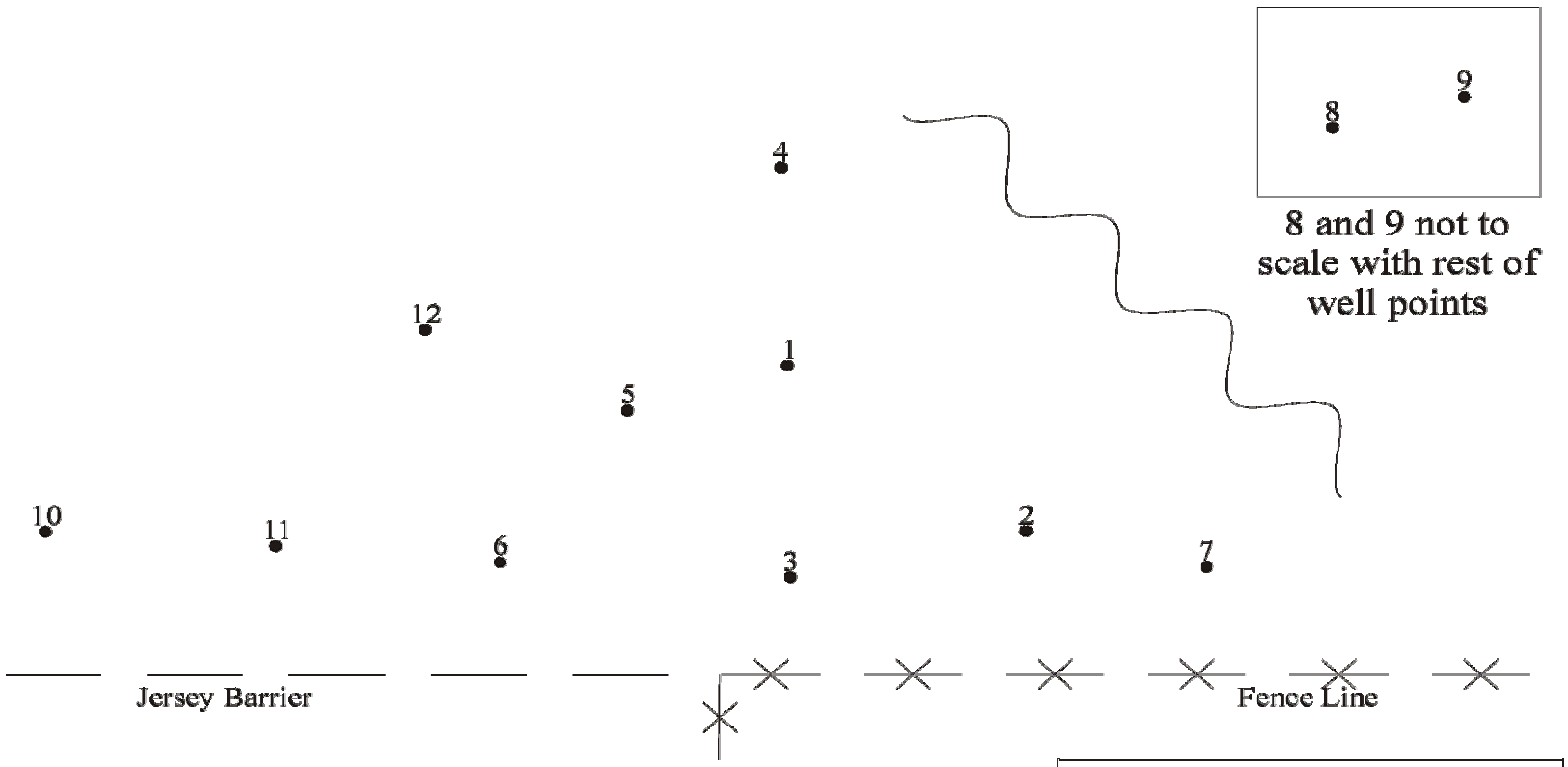
- Site map of Grissom ARB
- Contour plot of concentration
- Ground water contour maps

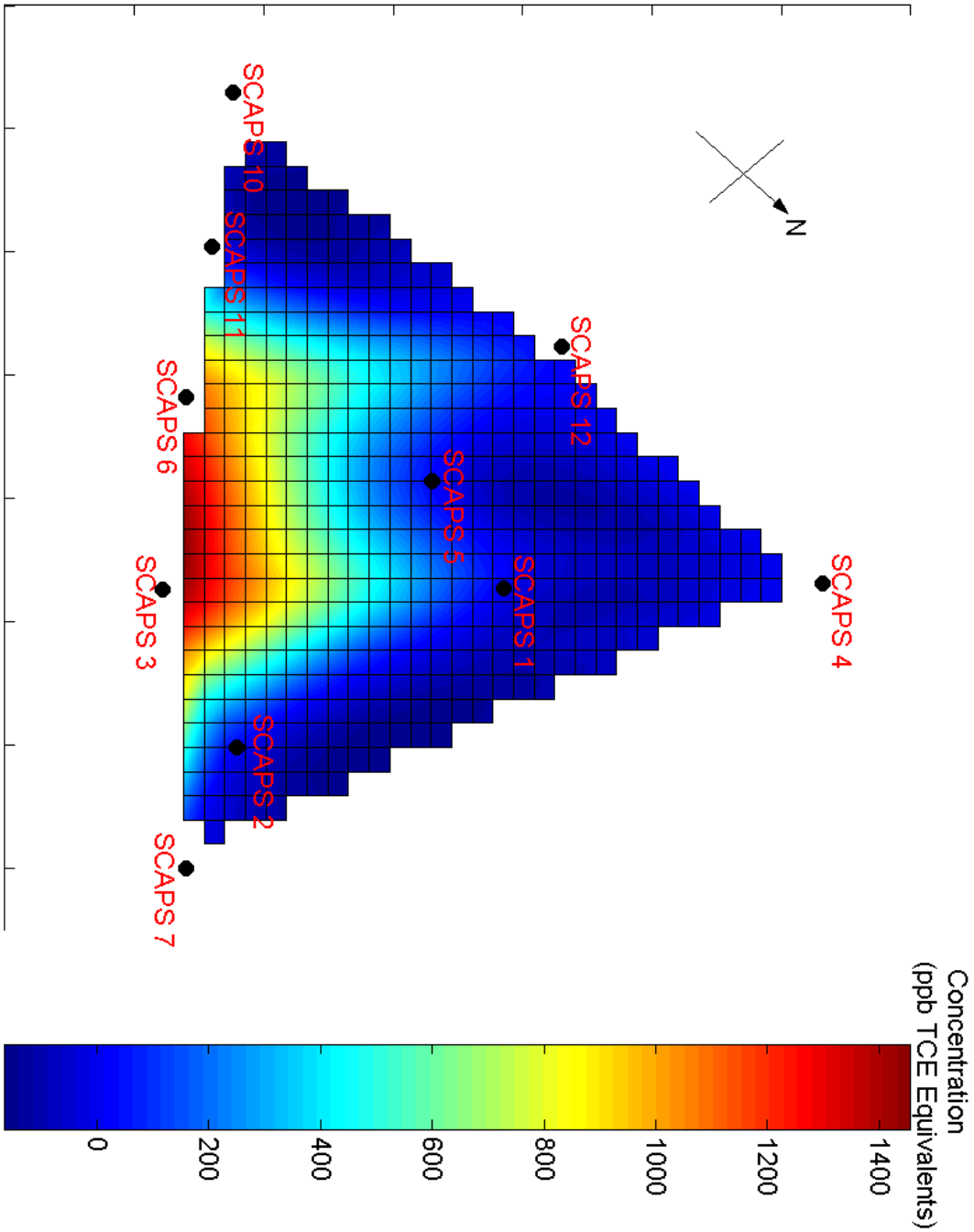
Appendix B is a compilation of data and maps for Rickenbacker IAP, OH:

- Site maps of Rickenbacker IAP
- Tabular concentrations found at site

Acknowledgements
Many people played a role in the successful completion of this field demonstration. Mr. Jerry Hansen of Brooks AFB, TX was the project manager for this work. USACE, KCD provided assistance with coordinating the field work and supplied SCAPS crew. Shaw Environmental provided planning, area maps, and access to the Rickenbacker site. Thank you to Mr. Alan Friedstrom and Ms. Marlene Seneca from the Air Force Real Property Agency for assistance with access and sponsorship to the sites.

APPENDIX A
Grissom ARB, IN


8
9
8 and 9 not to scale with rest of well points
4
12
1
5
10
11
6
3
2
7
Jersey Barrier
Fence Line
W
N
S
E
0
10
20
Scale in feet
• Well Point Locations


SCAPS 10
SCAPS 11
SCAPS 12
SCAPS 4
SCAPS 6
SCAPS 5
SCAPS 1
SCAPS 3
SCAPS 2
SCAPS 7
N
Concentration
(ppb TCE Equivalents)
0
200
400
600
800
1000
1200
1400

UTMs for Grissom Well Points (NAD 1983)

Well Point ID	North	East
SCAPS 1	16T0572437	4501496
SCAPS 2	16T0572445	4501500
SCAPS 3	16T0572445	4501491
SCAPS 4	16T0572434	4501502
SCAPS 5	16T0572434	4501492
SCAPS 6	16T0572438	4501488
SCAPS 7	16T0572453	4501502
SCAPS 8	skipped	
SCAPS 9	skipped	
SCAPS 10	16T0572425	4501474
SCAPS 11	16T0572432	4501481
SCAPS 12	16T0572428	4501489

FIGURE 1

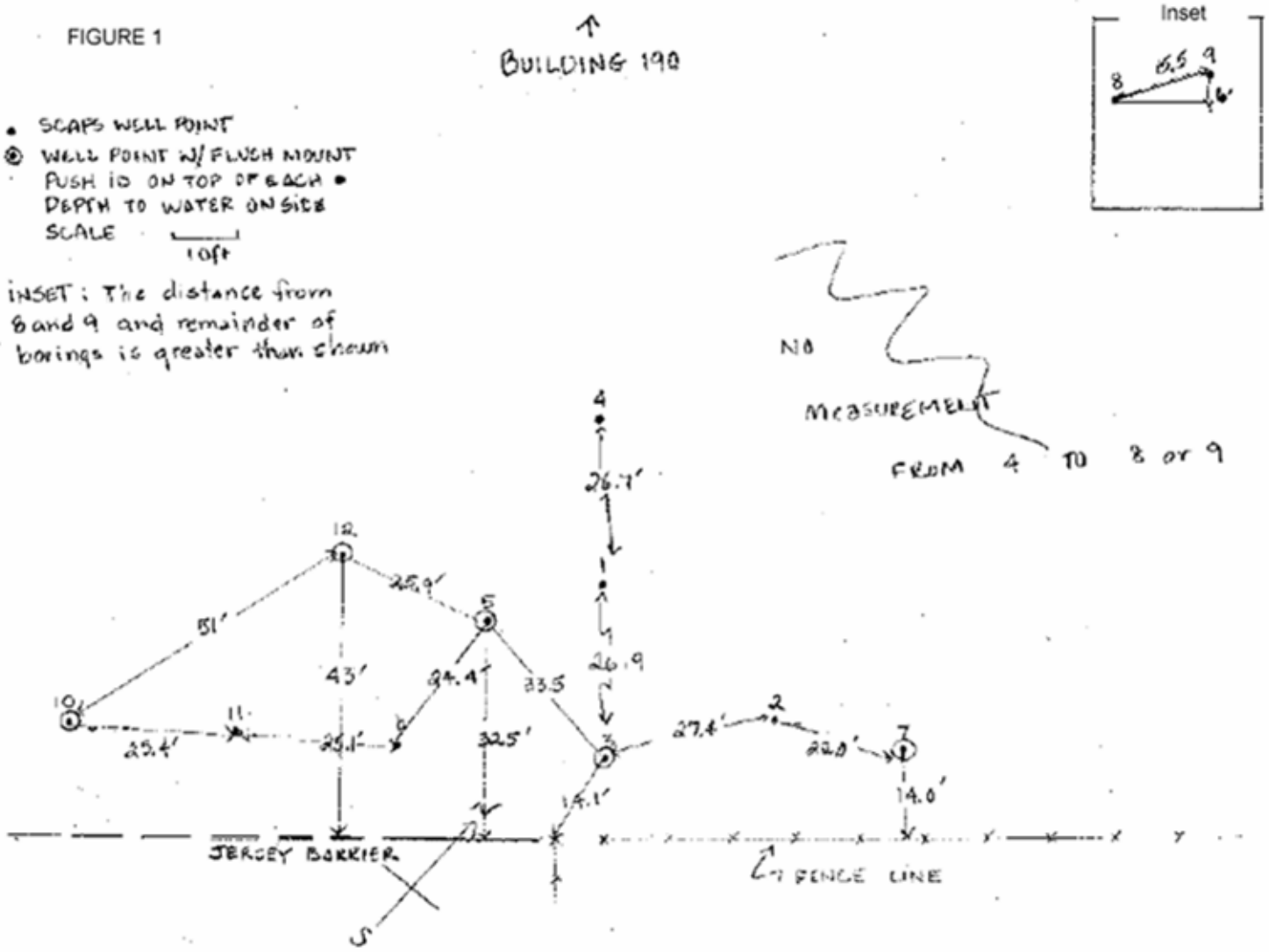

BUILDING 190
SCAPS WELL POINT
WELL POINT W/ FLUSH MOUNT PUSH ID ON TOP OF EACH • DEPTH TO WATER ON SIDE
SCALE 10ft
INSET: The distance from 8 and 9 and remainder of borings is greater than shown
Inset
8
6.5
9
6'
NO MEASUREMENT FROM 4 TO 8 or 9
4
26.7'
1
26.9
12
25.9'
5
51'
43'
34.4'
33.5
10
11
25.4'
25.1'
32.5'
3
27.4'
2
22.0'
7
14.0'
14.1'
JERSEY BARRIER
FENCE LINE
S

FIGURE 2

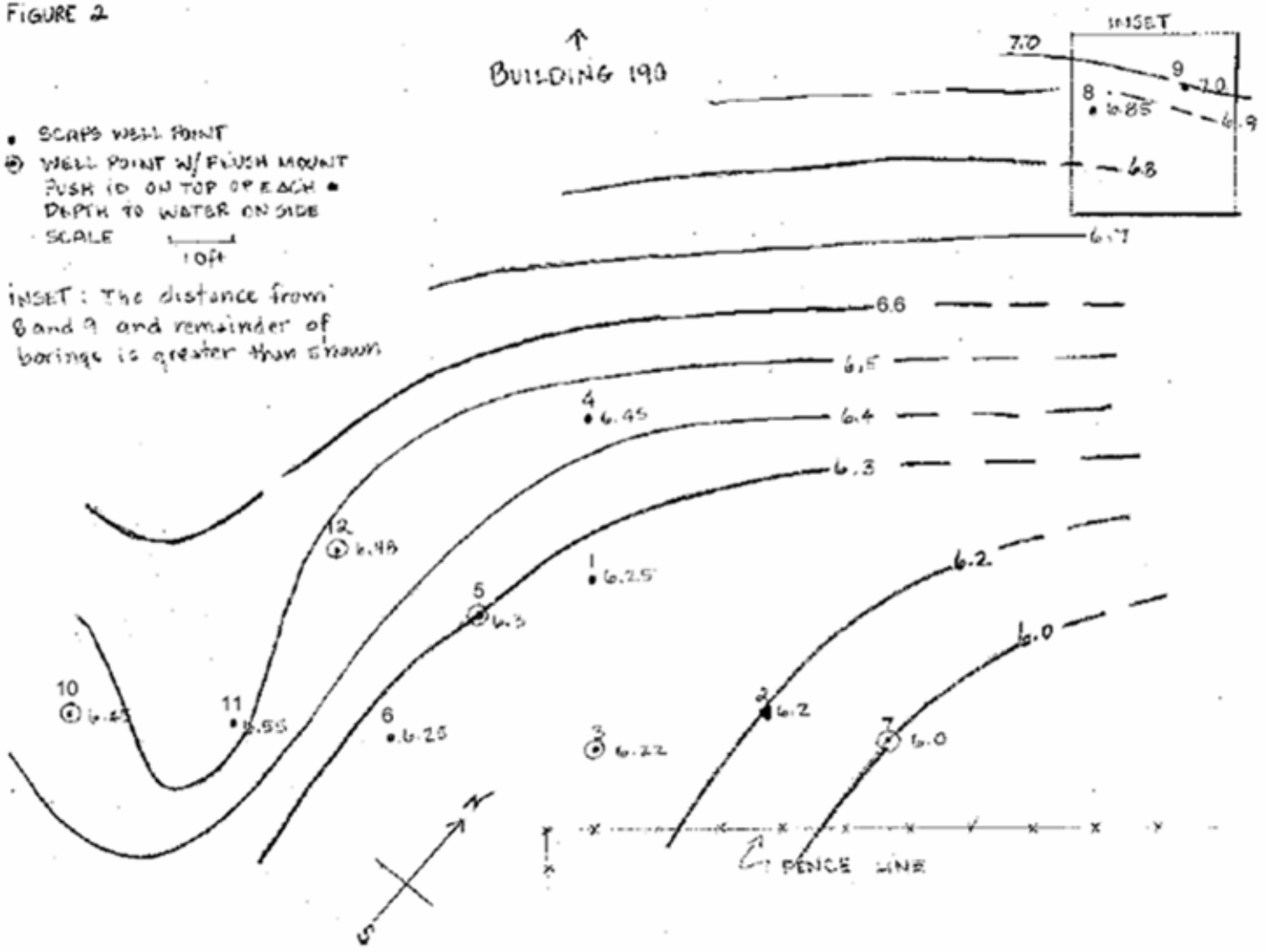

BUILDING 190
INSET
7.0
9
7.0
8
6.85
6.9
6.8
6.7
6.6
6.5
6.4
6.3
6.2
6.0
4
6.45
12
6.48
5
6.3
1
6.25
10
6.45
11
6.55
6
6.25
3
6.22
2
6.2
7
6.0
FENCE LINE
SCRAPS WELL POINT
WELL POINT W/ FLUSH MOUNT PUSH ID ON TOP OF EACH • DEPTH TO WATER ON SIDE
SCALE
10ft
INSET: The distance from 8 and 9 and remainder of boring is greater than 5'noun

Figure 3

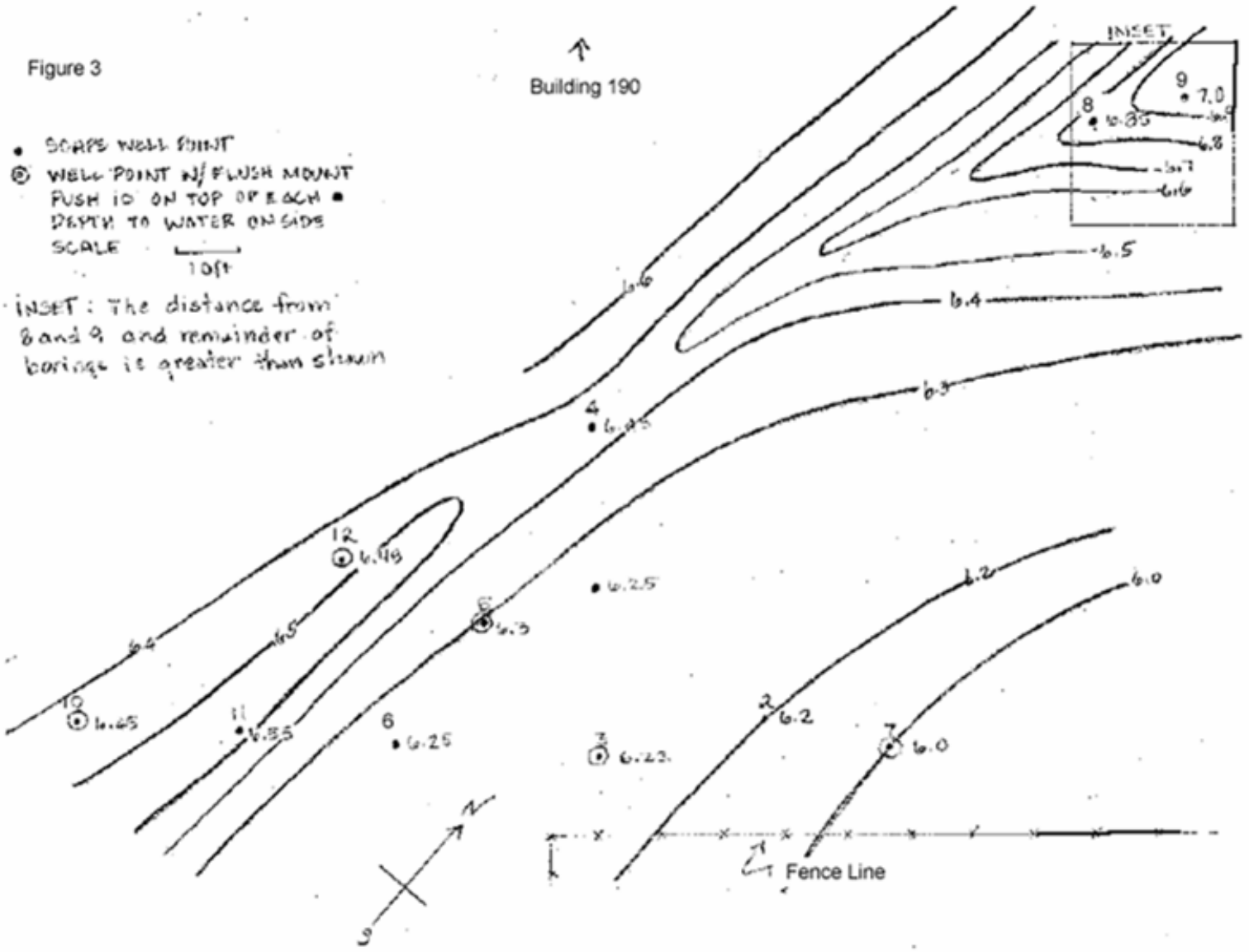
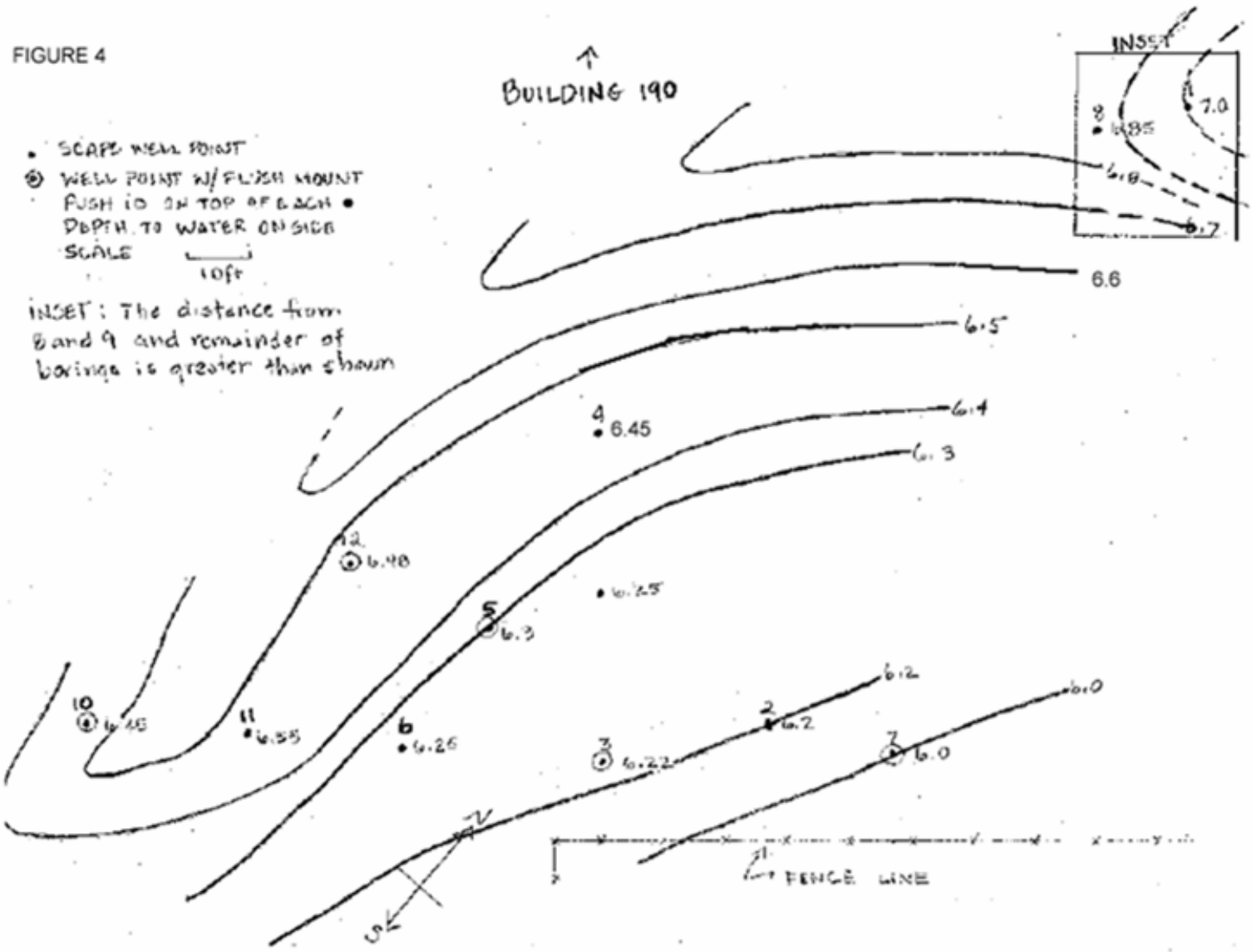
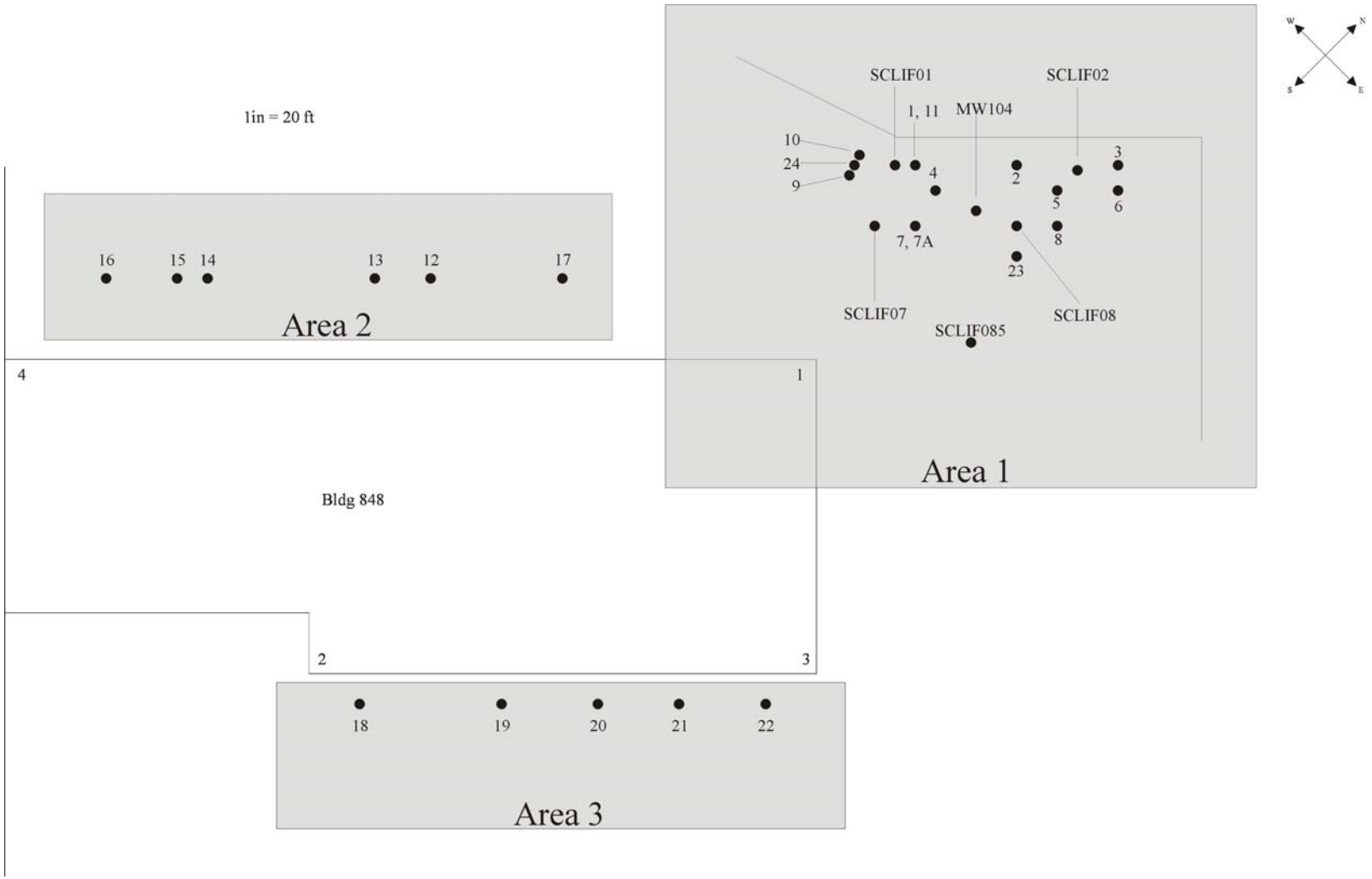

Building 190
• SCAPS WELL POINT
◎ WELL POINT W/ FLUSH MOUNT PUSH ID ON TOP OF EACH • DEPTH TO WATER ON SIDE
SCALE 10ft
INSET : The distance from 8 and 9 and remainder of boring is greater than shown
INSET
9 • 7.0
8 • 6.85
6.8
6.6
6.5
6.4
6.3
6.2
6.0
4 • 6.05
12 ◎ 6.08
6.4
6.5
10 ◎ 6.65
11 • 6.55
6 • 6.25
5 ◎ 6.3
• 6.25
3 ◎ 6.23
2 6.2
7 ◎ 6.0
N
Fence Line

FIGURE 4


BUILDING 190
• SCAPE WELL POINT
⊙ WELL POINT W/ FLUSH MOUNT PUSH ID ON TOP OF EACH • DEPTH TO WATER ON SIDE
SCALE 10ft
INSET: The distance from 8 and 9 and remainder of boring is greater than shown
INSET
8
6.85
7.0
6.8
6.7
6.6
6.5
6.4
6.3
4
6.45
12
6.48
6.45
5
6.3
10
6.48
11
6.55
6
6.26
6.2
2
6.2
3
6.22
7
6.0
6.0
FENCE LINE

APPENDIX B
Rickenbacker IAP, OH


1in = 20 ft
SCLIF01
SCLIF02
1, 11
MW104
10
24
9
4
2
3
5
6
7, 7A
8
23
SCLIF07
SCLIF08
SCLIF085
16
15
14
13
12
17
Area 2
Area 1
4
1
Bldg 848
2
3
18
19
20
21
22
Area 3
W
N
S
E

Well information at Rickenbacker IAP, OH

Well Point ID	Screen Interval (ft)	Refusal	Depth to water (ft)	uphole HaloProbe Results
SCAPS well 1 d	17-22	no	4.76	Non detect
SCAPS well 1 s	12-17	no	4.5	Non detect
SCAPS well 7 d	15 – 20	no	4.34	Non detect
SCAPS well 7 s	10 -15	no	4.12	12 ppb TCE equivalents
SCAPS well 14	10 – 20	no	5.33	Non detect
SCAPS well 16	8.7 - 18.7	YES	6.0	Non detect
SCAPS well 18	10 -20	no	6.23	Non detect
SCAPS well 20	9.5 -19.5	YES	6.13	Non detect
SCAPS well 22	10-20	no	5.7	Non detect